

Working Paper

SINGLE CHANNEL GROUND AND AIRBORNE RADIO SYSTEM (SINCGARS)
MAINTAINER TRAINING AND PERFORMANCE EVALUATION

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SINCGARS MAINTAINER TRAINING AND PERFORMANCE EVALUATION

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SINCGARS MAINTAINER TRAINING AND PERFORMANCE EVALUATION

REQUIREMENT

In conjunction with the MANPRINT evaluation of the Single Channel Ground and Airborne Radio System (SINCGARS) during the SINCGARS Follow-on Operational Test and Evaluation (FOT&E), a maintenance evaluation was conducted. ARI research psychologists were requested to observe the installation, operation, and maintenance of SINCGARS components and to gather and analyze MANPRINT-related maintenance performance data. Additionally, ARI was asked to assist in assessing SINCGARS maintainer (29E and 31V) training. This maintenance evaluation was considered an integral portion of the SINCGARS FOTE training issue.

PARTICIPANTS

The soldiers who participated in the maintenance training and tasks in conjunction with the FOT&E were 11 MOS-qualified SINCGARS maintainers. The MOSs were: ten 31Vs (unit level support) and one 29E (direct support). The 31Vs who participated as unit maintainers were representative of the 31V MOS population in terms of age, education, and rank. However, the warrant officer who provided direct support (DS) maintenance during the FOTE and the SFC were not representative of the enlisted 29E MOS population that will provide DS when the radio system is fielded (target audience is PFC through SSG). The total number of maintainer personnel trained included: 10 PVT to SP4 31Vs; 1 SFC 31V; 1 1LT 31V; 1 WO 29E; and 1 SFC 29E.

The soldiers who accomplished installation of SINCGARS in vehicles were unit (mechanized infantry and field artillery) maintenance personnel, 8 of whom had received SINCGARS-specific maintenance training (31V). Of the 10 soldiers surveyed, the distribution of MOSs was: 3 31Ks, 2 31Gs, 1 31C, and 4 31Vs. Ranks of these soldiers ranged from SP4 to SSG.

TRAINING

All SINCGARS FOTE maintainers completed 31V or 29E MOS maintainer training at Fort Sill prior to formal initiation of the FOTE. The 31V training involved approximately 40 hours of classroom instruction, and the 29E training provided approximately 80 hours of classroom instruction. All classes (31V and 29E) were conducted by instructors from the U.S. Army Signal School and Center, Fort Gordon, Georgia.

METHODOLOGY

There were two distinct maintenance-related components involved in this assessment: evaluation of training by questionnaires and maintenance performance, and evaluation of installation by questionnaires. Each evaluation is addressed independently below.

Training Evaluation. The maintenance performance of 31Vs was assessed by each 31V completing a brief form detailing the problem diagnosis for any SINCGARS

component that they turned in for repairs or replacement during the FOTE. On this form, the 29E (warrant officer) recorded whether or not the 31V maintainer had correctly diagnosed the malfunction. The 31V's performance was entered into a matrix similar to that shown in Figure 1.

| | | 31V Diagnoses | |
|----------------|----------------|--------------------------|--------------------------|
| | | Functional | Non-Functional |
| 29E Evaluation | Functional | true positive diagnosis | false negative diagnosis |
| | Non-Functional | false positive diagnosis | true negative diagnosis |

Figure 1. 31V diagnoses evaluation matrix.

A questionnaire was used to obtain student appraisals of the 31V maintainer training course and to gather appraisals of the adequacy of maintainer equipment. This instrument allowed for both rating responses and supporting comments or suggestions.

Installation Evaluation. Following completion of SINCGARS installation in vehicles, a questionnaire (Installation Debrief) was administered to installer personnel from both the mechanized infantry and field artillery units. This instrument incorporated rating, checklist, and listing items and covered topics of training adequacy, helpfulness of the manual, installation-related injuries, installation kit adequacy, tool shortfalls, and problematic installations.

FINDINGS

31V Evaluation of Training. The 31V maintainers completed a post-FOTE evaluation of the training they received. The timing of this evaluation was intended to avoid initial impressions of training and encourage assessment based on actual experiences using the training received. Summary statistics for the training evaluation questionnaire are presented in Table 1: low value mean ratings (1) indicated very inadequate training and high value mean ratings (5) indicated very adequate training. It may be seen that a majority of evaluated areas received mean ratings between 3 ("borderline") and 4 ("adequate"). Table 2 presents a list of 31V comments concerning training and maintenance experiences during the FOTE.

Table 1

31V Post-FOTE Evaluation of Training and Support Materials

| Item Content | N | Mean | Standard Deviation |
|------------------------------------|---|------|--------------------|
| Lesson 1: Introduction to SINCGARS | 9 | 3.78 | 1.30 |
| Practical Exercise 1 | 9 | 3.89 | 1.36 |

| Item Content | N | Mean | Standard Deviation |
|---|---|------|--------------------|
| Lesson 2: Introduction to Single Channel Operations | 9 | 3.89 | 1.36 |
| Practical Exercise 2 | 9 | 4.00 | 1.32 |
| Lesson 3: Introduction to Electronic Warfare | 9 | 3.22 | 1.20 |
| Lesson 4: Introduction to Frequency Hopping Operations | 9 | 3.67 | 1.22 |
| Practical Exercise 4 | 9 | 3.75 | 1.28 |
| Lesson 5: Frequency Hopping Net Operations | 9 | 3.67 | 1.22 |
| Practical Exercise 5 | 9 | 3.67 | 1.22 |
| Lesson 6: Introduction to RT-1439 | 9 | 3.89 | 1.36 |
| Practical Exercise 6 | 9 | 3.67 | 1.32 |
| Lesson 7: Secure Operations using VINSON TSEC/KY-57 | 9 | 3.56 | 1.24 |
| Lesson 8: Troubleshooting and Repair of Radio Set AN/PRC-119 with TSEC/KY-57 | 9 | 3.44 | 1.51 |
| Practical Exercise 8 | 9 | 3.38 | 1.60 |
| Lesson 9: AN/VIC-1 Intercom Functions | 9 | 3.63 | 1.41 |
| Practical Exercise 9 | 9 | 3.63 | 1.41 |
| Lesson 10: Introduction to Radio Set AN/VRC-90 with TSEC/KY-57 and AN/VIC-1 | 9 | 3.38 | 1.41 |
| Practical Exercise 10 | 9 | 3.56 | 1.33 |
| Lesson 11: Introduction to Control Monitor C-11291 with RT-1439 | 9 | 3.22 | 1.30 |
| Practical Exercise 11 | 9 | 3.22 | 1.30 |
| Lesson 12: Troubleshooting SINCGARS with TSEC/KY-57 and AN/VIC-1 | 9 | 3.44 | 1.42 |
| Final Review and Critique | 9 | 3.67 | 1.22 |
| Did instructors test your SINCGARS maintainer skills fairly and adequately? | 9 | 3.67 | 1.41 |
| Rate the adequacy of the tools you are provided to work on SINCGARS maintenance | 9 | 3.22 | 1.56 |
| Rate the adequacy of the manuals you are provided to work on SINCGARS maintenance | 9 | 3.56 | 1.01 |

Table 2

31V Evaluative Comments on Maintenance Training and Experience

| Content | MANPRINT Domain* |
|--|---------------------|
| More time should be spent on electronic warfare | T |
| Units need more electronic warfare training before soldiers are sent to school | T |
| RT-1439 lesson is overly adequate--31Vs don't need to know any more than basic functions of the RT | T |
| Training aids did not always point out exact problems directed by troubleshooting charts | T |
| Never had formal or informal training on SINCGARS troubleshooting | T |
| The course was paced and designed for all soldiers | T |
| Put more stress on troubleshooting SINCGARS with VIC-1 and KY-57 | T |
| A lot of weird symptoms occur with best pins on VINSON cable | HFE |
| If times (RT synchronization basis) are off, you can't talk | T |
| W-2 cable is worthless | HFE |
| Locking bar will not secure top radio properly | HFE |
| VINSON cable and audio and RT connectors need to be greatly improved | HFE |
| Troubleshooting systems with KY-57 is not covered in manual | T |
| Some problems only occur when vehicle is moving--this is not covered in the manual | T |
| Manual needs information about KY-57 and associated cables | T |
| Operator's course should be given to 31Vs | T |
| Instructors need to explain more about the equipment | T |
| There should be more stress on operator training--we encountered a lot of headspace in the field | T |
| More time and different situations are needed on troubleshooting systems | T |

* T = training, HFE = human factors engineering

For 31V training, soldiers rated 67% of the lessons and exercises as "adequate" (mean rating of 3.5 or above). Lesson content receiving weaker ratings included electronic warfare, troubleshooting and repair of AN/PRC-119 with KY-57, introduction to AN/VRC-90 with KY-57 and AN/VIC-1, introduction to Control Monitor C-11291 with RT-1439, and troubleshooting SINCGARS with KY-57 and AN/VIC-1.

A second opportunity for evaluation of 31V training was inherent in examining the actual maintenance performance during the FOTE of 31V soldiers. This was accomplished by obtaining data from the 29E direct support maintainer

on the diagnoses made by 31Vs. The 29E DS SINCGARS maintainer indicated that, overall, most 31Vs performed adequately—only 3 occasions (amplifier adapter, RT-1439, power amplifier) out of 31 total were found in which components reported by 31Vs as defective were actually not defective. The remaining items job ordered did have defects to be repaired at DS or higher level. Thus, 31Vs correctly diagnosed 90% of all the components they turned in to DS during the FOTE, as indicated in Figure 2. In view of the small sample of 31Vs ($N = 10$) and 29Es ($N = 1$) who participated in the FOTE and the small number of components found to be faulty ($N = 31$), no inferential treatment of results was provided.

| | | 31V Diagnoses | |
|----------------|----------------|---------------------------|---------------------------|
| | | Functional | Non-Functional |
| 29E Evaluation | Functional | true positive (n = 0) | false negative (n = 3) |
| | Non-Functional | false positive (n = 0) | true negative (n = 28) |

Figure 2. 31V diagnoses evaluation matrix.

29E Evaluation of Training. Only one 29E participated in the FOTE as a direct support SINCGARS maintainer. Because of this sample size, no statistical data were gathered. Further, as this person was a warrant officer with radio experience playing the role (by doctrine) of a young enlisted soldier, his performance was not considered representative of the target group and was subsequently not used in 29E training evaluation.

Evaluation of SINCGARS Installation. The issue of SINCGARS installation proved difficult—some observed installations and some of the data reported by installers were contaminated as a result of the necessity to use installation kits designed for other vehicles. The kits available were termed "Block one." They were different from the "Block three" installation kits required by some of the vehicles. The installers in the motor pool jerry-rigged installation kits made available in order to fit radios to vehicles. Hence, it must be respected that, for a number of vehicles, installation was considerably more lengthy than it should have been and some installation data, gathered by questionnaire, reflect problems associated with forced modifications of kits and procedures. Table 3 summarizes information provided by installers.

Table 3

SINCGARS Installation Problems and Efforts

| Content | Response |
|--|--|
| How well training prepared for installing? | Extremely Adequate 10% Very Adequate 40% Adequate 40% Borderline 0% Inadequate 0% Very Inadequate 0% Extremely Inadequate 10% |
| Any injury received while installing? | Yes* 40% No 60% |
| * Bump on head (M60, N = 3) * Busted knuckles (M113, N = 1; M151, N = 1; M981 N = 1; Vehicle not specified, N = 1) * Bruised ribs (M60, N = 1) | |
| Kits missing necessary parts? | Yes* 90% No 10% |
| * Dog house/VINSON mounts (most vehicles) * W-4/W-2 cable (most vehicles) * Power cable and antenna bracket (M151, M880) * Long bolts (M151) | |
| Installation effort analysis, by vehicle: (Mean manpower and mean time required) | |
| M35 M60A3 M91 M106 M113 M151A2 M561 M577 M981 M1009 | Manpower = 1.4 Time = 3.4hr Manpower = 1.7 Time = 3.3hr Manpower = 2.0 Time = 2.0hr Manpower = 2.0 Time = 3.8hr Manpower = 1.7 Time = 2.6hr Manpower = 1.7 Time = 1.8hr Manpower = 2.0 Time = 1.8hr Manpower = 1.8 Time = 2.3hr Manpower = 2.0 Time = 5.5hr Manpower = 2.0 Time = 1.0hr |
| Additional tools required for installation: | Drill and bits Hammer Vice grip Crow's foot wrench Multimeter Deepwell sockets Drop light |

Table 3 cont.

| Content | Response |
|------------------------------------|--|
| Problem installations, by vehicle: | M106 (modify/lower shelf) M113 (modify shelf) M151 (power cable and antenna bracket holes) M981 (modify shelf) |

CONCLUSIONS

A number of conclusions are suggested by the training evaluation and installation data available. However, these conclusions, as presented below, must be interpreted cautiously due to several limitations and unique conditions: a) small and unrepresentative sample of 29E personnel, and b) necessity of using some installation kits in vehicles other than those intended.

- o Ratings of the final review of the course, evaluation fairness, and adequacy of manuals were largely positive (adequate or better). However, soldiers rated the adequacy of tools provided as less than optimal.
- o The maintenance performance for 31Vs, as judged by the 90% correct component failure diagnosis rate, appears adequate within the limitations of the small sample (students and failures).
- o Training for the 29E MOS could not be evaluated because of the small sample and unrepresentative personnel actually trained.
- o SINCGARS installation into vehicle configurations was likely more problematic than necessary (or to be expected) because of the necessity to use some issued installation kits which were not intended for a given vehicle. This may or may not have contributed to reported shortfalls of tools and equipment and the requirement to accomplish a number of realinements (shelf modifications and drilling holes) in — SP certain vehicles.
- o Manpower and time requirements to accomplish installations could also have been adversely influenced by inability to use correct installation kits. In evaluating this possibility, particular attention should be given the M981, M106, M60A3, and M35 configurations. The injuries reported as sustained during installations do not appear unusual in rate or nature for work in a cramped environment.